The sweet option: the importance of *Aloe marlothii* for opportunistic avian nectarivores

Craig Symes

L'option douce : l'importance de *Aloe marlothii* pour des nectarivores aviens opportunistes. Les espèces de *Aloe* sont endémiques à l'Afrique, où elles sont répandues, offrant du nectar à une multitude d'espèces animales. Cet article résume les résultats d'une étude de trois ans, menée dans la Réserve naturelle du Suikerbosrand, Gauteng, Afrique du Sud, qui avait pour objectif d'examiner l'importance du nectar de *A. marlothii* pour les oiseaux. Le nectar est dilué et copieux et facilement accessible pour une multitude de nectarivores opportunistes (au moins 77 espèces) qui agissent comme pollinisateurs légitimes.

Summary. *Aloe* species are endemic and widespread in Africa, offering nectar to a host of animal species. This paper summarises the findings of a three-year study at Suikerbosrand Nature Reserve, South Africa, investigating the importance of *A. marlothii* nectar for birds. The nectar is dilute and copious and easily accessible to a host of opportunistic neactarivores (at least 77 species) that act as legitimate pollinators.

Aloe Linnaeus, species are widespread in the Afrotropical region with a concentration of diversity in southern Africa (Holland 1978, Reynolds 1969, Glen & Hardy 2000, Van Wyk & Smith 2005). A uniquely charismatic and widespread species found in South African savannas is *Aloe marlothii* A. Berger (Asphodelaceae), a single-stemmed aloe that grows up to 6 m in height (Reynolds 1969, Glen & Hardy 2000, Van Wyk & Smith 2005). Flowers vary in colour throughout their range from bright orange to red, and gaudy infloresences suggest pollination by birds (Reynolds 1969, Glen & Hardy 2000, Van Wyk & Smith 2005). The dilute nectar (*c.*12%), produced in copious amounts (*c.*250 µl/flower) during the dry winter period (June–September), when little else is flowering, attracts a host of opportunistic avian nectarivores (Symes & Nicolson 2008, Symes *et al.* 2008). Herein I summarise aspects of a three-year study investigating the symbiotic relationship of *A. marlothii* and a suite of avian opportunistic nectarivores.

An *Aloe marlothii* nectar oasis for birds

The first comprehensive documentation of birds feeding on *A. marlothii* nectar was by Oatley (1964) at Ndumu Game Reserve in northern KwaZulu-Natal. His list included 43 nectar-feeding bird species belonging to 21 families. Although earlier accounts exist (Marloth 1915), very little work has been done in understanding these animal–plant interactions. This prompted a study at a large aloe 'forest' at Suikerbosrand Nature Reserve, *c.*60 km south-east of Johannesburg, where large numbers of plants grow on rocky, north-facing slopes. During transects over six months almost half (38 of 83 species) of all species detected were recorded feeding on nectar (Symes *et al.* 2008). An additional four species were recorded feeding on nectar outside of transects (Symes *et al.* 2008). In most observations, birds were seen probing the compact arrangement of flowers on the near-horizontal racemes. However, for many birds the bright wash of orange pollen dusted on the facial area and belly was sufficient evidence for a nectar 'addiction' (Fig. 1). Overall, throughout the range of *A. marlothii*, at least 77 bird species are known to feed on the plant's nectar. Although most of the species observed feeding on nectar were residents, some species only appeared when nectar was available during flowering. During this period bird diversity and abundance increased significantly, suggesting that their arrival is dictated by the availability of the sugar-rich nectar of *A. marlothii*. One species that arrived in large numbers when *A. marlothii* flowered was Wattled Starling *Creatophora cinerea*. Most starlings (Sturnidae), mockingbirds (Mimidae), thrushes (Turdidae) and robins (Muscicapidae) are unable to digest sucrose, a C12 sugar comprising two C6 sugars, glucose and fructose (Martínez del Rio & Stevens 1989, Martínez del Rio *et al.* 1992, Lotz & Schondube 2006). However, most aloe nectars are glucose/fructose dominated (van Wyk *et al.* 1993) making their nectars suitable for a wider range of bird species.

Sunbird abundance during the flowering period at Suikerbosrand was notably low and

could be explained by nectar characteristics. Recent studies of plant–pollinator relationships suggest that nectar concentration and volume are important predictors of pollination syndromes, with nectars of high volume (40–100 µl/flower) and low concentration (8–12% w/w) focused towards generalist pollinators, and nectars of low volume (10–30 µl/flower) and high concentration (15–25% w/w) attracting specialist nectarivores e.g., sunbirds (Johnson & Nicolson 2008). However, in the Eastern Cape the response of birds to winter-flowering *A. ferox* might be quite different. Although the nectar in this ecologically similar aloe is of similar concentration and volume (180 µl, 12.5% w/w) it attracts large numbers of Malachite Sunbird *Nectarinia famosa* so other factors (like a lack of major foodplants at this season) besides nectar characteristics could be important determinants of plant visitors.

The natural world is an incredible assemblage of symbiotic relationships. Birds eat nectar but how do aloes benefit? By feeding in a manner where pollen is deposited onto feathers, generalist birds act as important pollinators of *A. marlothii*. This was confirmed during two flowering seasons by conducting pollinator exclusion experiments (Symes *et al.* 2009). Honeybees *Apis mellifera* also visited aloes but in smaller numbers; they are probably excluded as pollinators because the nectar is more dilute than they prefer and because they were present in such low numbers at this specific site; where numbers are greater their role as pollinators might be more important.

The tubular length of *A. marlothii* flowers (*c.*33 mm) suggests a specialist bird-pollinated syndrome (i.e. sunbirds). However, because large amounts of nectar ooze from the flower opening, many short-billed birds can access the nectar without damaging flowers. No birds have been observed (like Cape White-eye *Zosterops capensis*) robbing nectar, confirming the legitimacy of most visitors as true pollinators.

Of particular importance to the study was the use of stable isotopes, a technique that was in its infancy in the 1960s when Terry Oatley made his observations of opportunistic nectarivory at *A. marlothii*. Stable carbon isotopes are a useful tool in understanding animal diets because they quantify assimilated material, and depending on the tissue studied (which is related to turnover rates of tissue) provide a window into different dietary time periods. *A. marlothii* employs a unique water-saving carbon fixation pathway during photosynthesis (i.e. crassulacean acid metabolism or CAM photosynthesis), which is found in many plants of arid regions. Because of this, it has a unique carbon isotopic signature compared to C_3 photosynthesising plants. By measuring the carbon isotopic signature ($\delta^{13}C$) in whole blood before, during and after flowering, I was able to track the dietary shift of birds from that of a C_3 photosynthetic source (i.e. broad-leaved plants) to nectar (with a CAM isotope signature). Furthermore, by measuring carbon isotope signatures of CO_2 in breath samples I was able to determine the importance of nectar sugars as a readily available energy source for birds; this is because carbon in breath represents immediately metabolised carbohydrates (Symes *et al.* in prep.). The analysis of breath also indicated that analysis of blood under-estimated the importance of nectar sugars for most nectar-feeding birds.

Table 1. Number of extant species in dominant nectarivore families for each zoogeographic region (shaded), including sunbirds (Nectariniidae), sugarbirds (Promeropidae), honeyeaters (Meliphagidae) and hummingbirds (Trochilidae) (after Maclean 1990).

Tableau 1. Nombre d'espèces dans les familles essentiellement nectarivores pour chaque région zoogéographique (hachuré) : souimangas (Nectariniidae), prométops (Promeropidae), méliphages (Meliphagidae) et colibris (Trochilidae) (d'après Maclean 1990).

	Neotropics	Nearctic	Palaearctic	Afrotropics	Indo-Malaya	Australasia	Total
Trochilidae	324	13	0	0	0	0	337
Nectariniidae	0	0	2	78	39	2	121
Promeropidae	0	0	0	2	0	0	2
Meliphagidae	0	0	0	0	10	159	169
	324	13	2	80	49	161	629

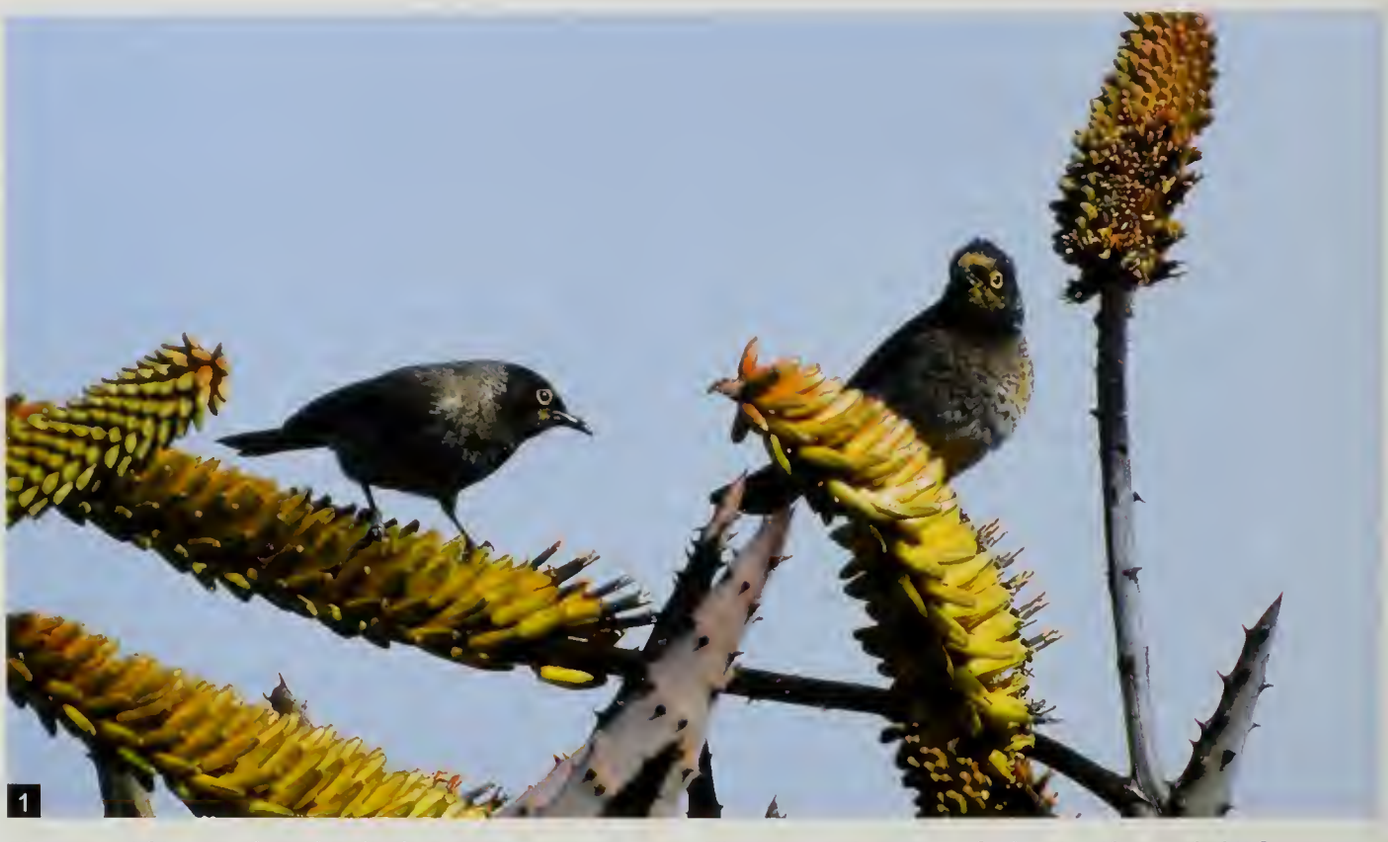

Figure 1. African Red-eyed Bulbuls *Pycnonotus nigricans* feeding on *Aloe marlothii* flowers. The study site formed a region of overlap with Dark-capped Bulbul *Pycnonotus tricolor* (which were never observed, although hybrids were) (Craig Symes)

Bulbuls brunoirs *Pycnonotus nigricans* se nourrissant sur les fleurs de *Aloe marlothii*. Le site d'étude formait une zone de chevauchement avec le Bulbul des jardins *Pycnonotus barbatus tricolor* (qui n'a jamais été observé, bien que des hybrides ont été vus) (Craig Symes)

Figure 2. Avian nectar feeders in *Aloe marlothii* forest at Suikerbosrand Nature Reserve, Gauteng (a–f) and common avian pollinators showing pollen dusted on facial area from feeding on nectar (g–j).

(a) Immature male Malachite Sunbird *Nectarinia famosa* and African Red-eyed Bulbul *Pycnonotus nigricans*; **(b)** *Aloe marlothii* inflorescences; **(c)** Cape White-eye *Zosterops capensis*; **(d)** immature male Malachite Sunbird *Nectarinia famosa* probing flowers on raceme; **(e)** Wattled Starling *Creatophora cinerea*; **(f)** inflorescence with Fiscal Flycatcher *Sigelus silens* perched on open flowers; **(g)** adult male Cape Weaver *Ploceus capensis*; **(h)** Black-collared Barbet *Lybius torquatus*; **(i)** female Wattled Starling *Creatophora cinerea*; **(j)** Red-faced Mousebird *Urocolius indicus* (Craig Symes)

Oiseaux se nourrissant de nectar dans une forêt de *Aloe marlothii*, Réserve naturelle du Suikerbosrand, Gauteng, Afrique du Sud (a–f) et pollinisateurs aviens communs avec du pollen sur leur face OK après avoir pris du nectar (g–j).

(a) Souimanga malachite *Nectarinia famosa* mâle immature et Bulbul brunoir *Pycnonotus nigricans* ; **(b)** inflorescences de *Aloe marlothii* ; **(c)** Zostérops du Cap *Zosterops capensis* ; **(d)** Souimanga malachite mâle immature explorant des fleurs ; **(e)** Etourneau caronculé *Creatophora cinerea* ; **(f)** inflorescence avec un Gobemouche fiscal *Sigelus silens* perché sur des fleurs ouvertes ; **(g)** Tisserin du Cap *Ploceus capensis* mâle adulte ; **(h)** Barbican à collier *Lybius torquatus* ; **(i)** Etourneau caronculé *Creatophora cinerea* femelle ; **(j)** Coliou quiriva *Urocolius indicus* (Craig Symes)


2b


2c


2d


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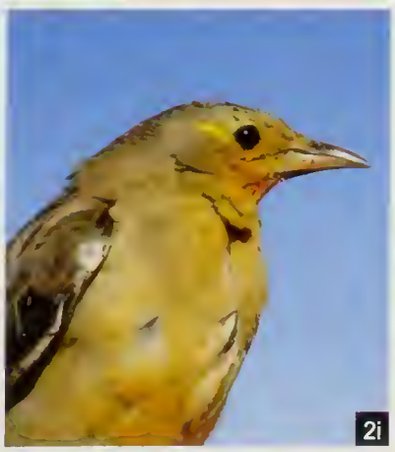
2f


2g


2h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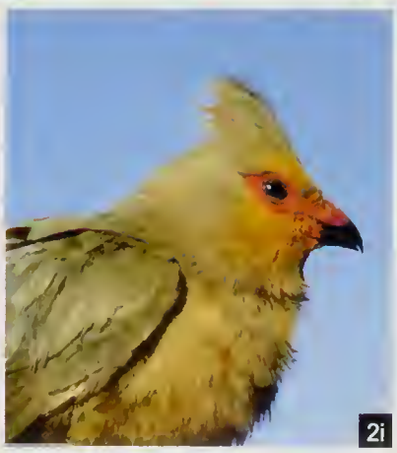
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Avian nectarivory in the Afrotropics

Avian nectarivory is most broadly dominated by three families: the New World hummingbirds (Trochilidae), the Old World sunbirds (Nectariniidae) and the Australo-Pacific honeyeaters (Meliphagidae) (Maclean 1990; Table 1). The sugarbirds (Promeropidae, two species) were once considered a unique nectar-feeding family of Africa, although a recent study suggests additions to this taxon (i.e. Grey-chested Illadopsis *Kakamega poliothorax,* Spot-throat *Modulatrix stictigula* and Dapple-throat *Arcanator orostruthus*) that are not nectar feeders (Beresford *et al.* 2005). Nectar-feeding is not confined to specialist taxa and occurs in a wide range of other families. In the Neotropics the number of nectar-feeding specialists, besides hummingbirds, is comparatively low and includes members of the Dacnini and Coerebini, tribes of the Thraupidae and Parulidae respectively (Burns *et al.* 2003, Dickinson 2003). In some regions where these major nectarivore families have not colonised, and monopolised the nectar-feeding niche, diversification within other families has occurred (Nicolson & Fleming 2003). These include, for example, the Hawaiian honeycreepers (Drepanidinae) (Pratt 2005), the asities and sunbird-asities (Philepittidae; four species) of Madagascar (Prum 1993, Irestedt *et al.* 2001), the Irenidae (fairy-bluebirds; two species), Chloropseidae (leafbirds; eight species) and Aegithinidae (ioras; four species) of the Indo-Malayan Region (Wells *et al.* 2003a, Dickinson 2003, Fuchs *et al.* 2006), and the Dicaeidae (flowerpeckers, 42 species) of Australasia (Delacour 1944, Beecher 1953, Sibley & Ahlquist, 1991, Ericson & Johansson 2003). The enigmatic Lorinae (Psittacidae) of Australasia are also uniquely adapted for nectarivory with a brush-tip tongue (Forshaw 2006), as is a single member of the Timalidae (babblers), the Fire-tailed Myzornis *Myzornis pyrrhoura* (Wells *et al.* 2003b). However, the Melanocharitidae (berrypeckers, 12 species) of New Guinea lack the specialised structure of the tongue for feeding on nectar (Beehler *et al.* 1986). The stitchbird (Notiomystidae), recently relegated to a monotypic family (from Meliphagidae), is a nectar-feeder endemic to New Zealand (Driskel *et al.* 2007).

In the Afrotropics the overall diversity of opportunistic nectar-feeding birds is unknown. This study has highlighted the high diversity of opportunistic nectar feeders for a single aloe species in southern Africa. Therefore, for the rest of the continent this list could be greatly increased. To date the diversity of opportunistic nectarivores appears greater than in other zoogeographic regions, and is probably explained by the different feeding roles of birds in different regions. In the Australo-Pacific region the equivalent role of opportunistic nectarivores might be filled by honeyeaters with broader dietary requirements, whilst in the Afrotropics the role of opportunistic nectarivores may be filled by several families that do not typically feed on nectar (Keast 1985; Appendix). Furthermore, competition of opportunistic nectarivores with specialist nectarivores (i.e. sunbirds) in the Afrotropics could be high, thereby explaining the low number of sunbird species in the Afrotropics compared to the number of hummingbird and honeyeater species in the Neotropics and Australasia respectively, where there are fewer opportunistic nectarivores (Table 1). An alternative explanation may relate to degrees of weather predictability and associated plant assemblages and flowering patterns in each of the regions.

Other interactions involving aloes

Aloe marlothii nectar is important for many other organisms besides birds and the use of nectar might be an important determinant of local movements for Chacma Baboons *Papio hamadryas ursinus*. Observations suggest that troops with ranges that overlap with *A. marlothii* make greater use of the aloe forest during flowering, utilising nectar and succulent leaves as a food and water source (pers. obs.). During periods of low rainfall other mammal species might make use of *Aloe* nectar but may occur in such low numbers that the scale of competition with birds is low.

Aloe marlothii is also important to birds for many other reasons. The most abundant bird species recorded during censuses was Laughing Dove *Streptopelia senegalensis*, a species that seldom (if ever) fed on nectar. It was observed nesting during drier months (August–September) on horizontal leaves of tall aloes. Although the spines of aloes afford protection from predators, baboons are able to ascend plants to access nectar or rob nests. Also, avian predators might still pose a threat; in one instance a Pied Crow *Corvus albus* was recorded robbing a nest with eggs (pers. obs.);

the latter species was, however, never observed feeding on nectar. Aloes also benefited birds in other ways besides providing nectar. Water collected after rains in the horizontal leaves was used as a drinking and bathing source by birds. Barbets excavated nesting cavities in trunks of tall aloes, and the dry leaf skirt was used as a protected site for birds to construct nests (e.g. Fiscal Flycatcher *Sigelus silens*).

Conclusion

The list of birds recorded feeding on aloes has increased from that previously known and includes at least 101 species in 26 families (Appendix). Some species might irregularly feed on nectar and observations of them doing so might be rare: *A. marlothii* is a widespread species in southern Africa and the number of species feeding on its nectar could therefore exceed 77 species. This phenomenal diversity of opportunistic nectarivores is possibly the highest number of bird species recorded feeding on the nectar of a single plant species worldwide (Appendix 1).

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School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, P/Bag 3, WITS, 2050, South Africa. E-mail: craig.symes@wits.ac.za

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Appendix 1. Bird species recorded feeding on, or suspected of feeding on, *Aloe marlothii* nectar.
Dominant feeding guild (after Maclean 1993): fr = frugivore, gr = granivore, in = insectivore, ne = nectarivore, om = omnivore.
Level of nectarivory (after Oatley 1964): 0 = non-feeder but present therefore suspected feeder, 1 = occasional, 2 = casual, 3 = regular, 4 = addict, 5 = true nectarivore.
SNR = recorded at Suikerbosrand Nature Reserve.
References: 1 = Oatley (1964), 2 = Skead (1967), 3 = Oatley & Skead (1972), 4 = Hoffman (1988) (records attributed to *A. ferox*), 5 = Maclean (1993), 6 = Oatley (2001), 7 = pers. obs., 8 = this study, 9 = A. Craig pers. comm. (records attributed to *A. ferox*), 10 = B. de Boer pers. comm., 11 = M. Kriek pers. comm., 12 = C. Botes unpubl. data. Taxonomy follows Hockey *et al.* (2005).
* *Buphagus erythrorhynchus* was observed for the first time at the study site (first known record for SNR) only during the flowering period and is by association with *A. marlothii* recorded as a nectar feeder.

Annexe 1. Espèces d'oiseaux ayant été observées en train de se nourrir du nectar de *Aloe marlothii* ou suspectées de le faire.
Régime alimentaire dominant (d'après Maclean 1993) : fr = frugivore, gr = granivore, in = insectivore, ne = nectarivore, om = omnivore.
Niveau de nectivorie (d'après Oatley 1964) : 0 = n'a pas été observé se nourrissant de nectar mais présent et ainsi suspecté de le faire, 1 = accidentel, 2 = occasionnel, 3 = régulier, 4 = très régulier, 5 = vrai nectarivore.
SNR = observé dans la Réserve naturelle du Suikerbosrand.
Références : 1 = Oatley (1964), 2 = Skead (1967), 3 = Oatley & Skead (1972), 4 = Hoffman (1988) (mentions attribuées à *A. ferox*), 5 = Maclean (1993), 6 = Oatley (2001), 7 = obs. pers., 8 = cette étude, 9 = A. Craig comm. pers. (mentions attribuées à *A. ferox*), 10 = B. de Boer comm. pers., 11 = M. Kriek comm. pers., 12 = C. Botes données non publiées. La taxonomie suit Hockey *et al.* (2005).
* *Buphagus erythrorhynchus* a été observé pour la première fois sur le site d'étude (première mention connue pour SNR) uniquement pendant la période de floraison et est considéré comme un nectarivore par son association avec *A. marlothii*.

Species and family	Scientific Name	Feeding Guild	Level of nectarivory	SNR	Refs.
Indicatoridae					
Lesser Honeyguide	*Indicator minor*	In	1	1	3
Picidae					
Cardinal Woodpecker	*Dendropicos fuscescens*	In	1	1	8
Lybiidae					
White-eared Barbet	*Stactolaema leucotis*	Fr/In	2	-	1
Yellow-rumped Tinkerbird	*Pogoniulus bilineatus*	Fr/In	1	-	3
Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*	Fr/In	2	-	10
Red-fronted Tinkerbird	*Pogoniulus pusillus*	Fr/In	2	-	1
Acacia Pied Barbet	*Tricholaema leucomelas*	Fr	2	1	1, 3, 8
Black-collared Barbet	*Lybius torquatus*	Fr/In	2	1	1, 3, 8
Crested Barbet	*Trachyphonus vaillantii*	In/Fr	1	1	3, 8
Phoeniculidae					
Green Woodhoopoe	*Phoeniculus purpureus*	In	1	1	3
Rhinopomastidae					
Common Scimitarbill	*Rhinopomastus cyanomelas*	In	1	1	1, 3, 8,11
Coliidae					
White-backed Mousebird	*Colius colius*	Fr/Fo	2	1	3
Speckled Mousebird	*Colius striatus*	Fr/Fo	4	1	1, 2, 3, 8,12
Red-faced Mousebird	*Urocolius indicus*	Fr/Fo	4	1	1, 3, 8
Psittacidae					
Brown-headed Parrot	*Poicephalus cryptoxanthus*	Fr	4	-	1
Musophagidae					
Grey Go-away-bird	*Corythaixoides concolor*	Fr/Fo	3	1	3, 7
Columbidae					
Laughing Dove	*Streptopelia senegalensis*	Gr/In	1	1	1, 3, 8
Cape Turtle Dove	*Streptopelia capicola*	Gr/In	1	1	1, 3
Oriolidae					
Black-headed Oriole	*Oriolus larvatus*	In/Fr	3	1	1, 2, 3, 9,10
Dicruridae					
Fork-tailed Drongo	*Dicrurus adsimilis*	In/Ca	3	-	1, 2, 3, 9,12
Malaconotidae					
Brown-crowned Tchagra	*Tchagra australis*	In	1	1	8
Southern Boubou	*Laniarius ferrugineus*	In/Fr	3	1	1, 3
Corvidae					
Pied Crow	*Corvus albus*	Ca/Gr/Fr	1	1	3
White-necked Raven	*Corvus albicollis*	Ca	3	1	Garland in 1, 3
Paridae					
Grey Penduline Tit	*Anthoscopus caroli*	In	3	-	1
Southern Black Tit	*Parus niger*	In	2	-	1, 3
Pycnonotidae					
Dark-capped Bulbul	*Pycnonotus tricolor*	Fr/In	4	1	1, 3, 11
African Red-eyed Bulbul	*Pycnonotus nigricans*	Fr/In	4	1	3, 8
Cape Bulbul	*Pycnonotus capensis*	Fr	3	-	5
Sombre Greenbul	*Andropadus importunus*	In/Fr	4	-	1, 3,12
Terrestrial Brownbul	*Phyllastrephus terrestris*	In/Fr	4	-	1
Sylviidae					
Cape Grassbird	*Sphenoeacus afer*	In	1	1	3, 8
Yellow-bellied Eremomela	*Eremomela icteropygialis*	In	1	1	3
Burnt-necked Eremomela	*Eremomela usticollis*	In	2	-	1
Long-billed Crombec	*Sylvietta rufescens*	In	2	1	1, 3, 8
Arrow-marked Babbler	*Turdoides jardineii*	In/Fr	2	-	1, 3

Species and family	Scientific Name	Feeding Guild	Level of nectarivory	SNR	Refs.
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	In/Fr	1	1	3, 8
Zosteropidae					
African Yellow White-eye	*Zosterops senegalensis*	In/Fr	3	-	1
Cape White-eye	*Zosterops capensis*	In/Fr	4	1	2, 3, 8, 9,10,12
Cisticolidae					
Rattling Cisticola	*Cisticola chiniana*	In	4	1	1, 3, 8
Neddicky	*Cisticola fulvicapilla*	In	4	1	1, 3, 8
Tawny-flanked Prinia	*Prinia subflava*	In	3	1	1, 3
Black-chested Prinia	*Prinia flavicans*	In	3	1	3, 8
Karoo Prinia	*Prinia maculosa*	In	1	-	3
Bar-throated Apalis	*Apalis thoracica*	In	2	1	8
Yellow-breasted Apalis	*Apalis flavida*	In/Fr	1	-	1, 3
Rudd's Apalis	*Apalis ruddi*	In	3	-	3
Muscicapidae					1
Cape Rock Thrush	*Monticola rupestris*	In/Fr	1	1	3, 8,12
Pale Flycatcher	*Bradornis pallidus*	In/Fr	2	-	1
Southern Black Flycatcher	*Melaenornis pammelaina*	In/Fr	2	-	1
Fiscal Flycatcher	*Sigelus silens*	In/Fr	3	1	1, 3, 8
African Dusky Flycatcher	*Muscicapa adusta*	In/Fr	2	-	12
Cape Robin-Chat	*Cossypha caffra*	In/Fr	1	1	8
White-browed Scrub-Robin	*Cercotrichas leucophrys*	In/Fr	2	-	1
Buff-streaked Chat	*Oenanthe bifasciata*	In	3	-	3
Mocking Cliff Chat	*Thamnolaea cinnamomeiventris*	In/Fr	1	1	3
Sturnidae					
Red-winged Starling	*Onychognathus morio*	Fr/In	3	1	3, 4, 7, 9,12
Black-bellied Starling	*Lamprotornis corruscus*	Fr/In	3	-	1, 3
Cape Glossy Starling	*Lamprotornis nitens*	In/Fr	3	1	1, 3, 7, 8, 9
Pied Starling	*Spreo bicolor*	In/Fr	3	1	3, 9
Wattled Starling	*Creatophora cinerea*	In/Fr	1	1	8
Red-billed Oxpecker*	*Buphagus erythrorhynchus*	In	0	1	8
Nectarinidae					
Olive Sunbird	*Cyanomitra olivacea*	Ne/In	5	-	-
Grey Sunbird	*Cyanomitra veroxii*	Ne/In	5	-	-
Amethyst Sunbird	*Chalcomitra amethystina*	Ne/In	5	1	2, 4, 7, 9,12
Scarlet-chested Sunbird	*Chalcomitra senegalensis*	Ne/In	5	-	2, 7
Bronzy Sunbird	*Nectarinia kilimensis*	Ne/In	5	-	2
Malachite Sunbird	*Nectarinia famosa*	Ne/In	5	1	2, 7, 8, 9,12
Collared Sunbird	*Hedydipna collaris*	Ne/In	5	-	7,12
Southern Double-collared Sunbird	*Cinnyris chalybeus*	Ne/In	5	-	2, 4, 7, 9
Greater Double-collared Sunbird	*Cinnyris afer*	Ne/In	5	-	2, 7, 9,12
White-bellied Sunbird	*Cinnyris talatala*	Ne/In	5	1	2, 7, 8
Dusky Sunbird	*Cinnyris fuscus*	Ne/In	5	-	2, 6, 9
Marico Sunbird	*Cinnyris mariquensis*	Ne/In	5	-	2, 6
Promeropidae					
Gurney's Sugarbird	*Promerops gurneyi*	Ne/In	5	-	2
Cape Sugarbird	*Promerops cafer*	Ne/In	5	-	2
Ploceidae					
Lesser Masked Weaver	*Ploceus intermedius*	In/Gr	3	-	5
Spectacled Weaver	*Ploceus ocularis*	In/Fr/Gr	4	-	1
Cape Weaver	*Ploceus capensis*	In/Gr	3	1	2, 3, 4, 7, 8, 9
Yellow Weaver	*Ploceus subaureus*	In/Gr/Fr	4	-	1, 3
Southern Masked Weaver	*Ploceus velatus*	In/Gr	4	1	1, 3, 8

Species and family	Scientific Name	Feeding Guild	Level of nectarivory	SNR	Refs.
Village Weaver	*Ploceus cucullatus*	In/Gr	4	-	1, 2, 3
Dark-backed Weaver	*Ploceus bicolor*	In/Fr	2	-	1
White-winged Widowbird	*Euplectes albonotatus*	Gr/In	1	-	3
Red-collared Widowbird	*Euplectes ardens*	Gr/In	1	1	3, 8
Estrildidae					
Black-faced Waxbill	*Estrilda erythronotos*	Gr/In	1	1	3, 8
Common Waxbill	*Estrilda astrild*	Gr/Fr	1	1	3
Violet-eared Waxbill	*Granatina granatina*	Gr	1	1	8
Green-winged Pytilia	*Pytilia melba*	Gr	1	1	8
Jameson's Firefinch	*Lagonosticta rhodopareia*	Gr	1	1	8
Passeridae					
House Sparrow	*Passer domesticus*	Gr/Fr/In	1	1	3
Cape Sparrow	*Passer melanurus*	Gr/In/Fr	1	1	3
Southern Grey-headed Sparrow	*Passer diffusus*	Gr/In	2	1	3, 8
Yellow-throated Petronia	*Petronia superciliaris*	In/Gr	2	1	1, 2, 3
Fringillidae					
Black-throated Canary	*Serinus atrogularis*	Gr/In	1	1	3, 8
Yellow-fronted Canary	*Serinus mozambicus*	Gr/In/Fo	3	1	1, 2, 3
Yellow Canary	*Serinus flaviventris*	Gr/In/Fo	2	1	3
Brimstone Canary	*Serinus sulphuratus*	Gr/Fr/Fo	3	1	1, 2, 3
Streaky-headed Seedeater	*Serinus gularis*	Gr/Fo	3	1	1, 3, 4, 8,12
Cinnamon-breasted Bunting	*Emberiza tahapisi*	Gr/In	1	1	8
Cape Bunting	*Emberiza capensis*	Gr	1	1	8
Total number of species		101			